NUHTD6
ISSN: 0149-5720

NUMERICAL HEAT TRANSFER

An International Journal of Computation and Methodology

VOLUME 8 1985

NUMERICAL HEAT TRANSFER

An International Journal of Computation and Methodology

Editor-in-Chief
W. J. MINKOWYCZ
University of Illinois at Chicago
Department of Mechanical Engineering
Chicago, Illinois 60680
(312) 996-3467/5317

Assistant to the Editor-in-Chief: **R. M. Szandra**

EDITORIAL ADVISORY BOARD

E. M. Sparrow, *Chairman*
Minneapolis, Minnesota

A. J. Baker, *Knoxville, Tennessee*
B. Berkovsky, *Moscow, USSR*
T. Cebeci, *Long Beach, California*
B. T. Chao, *Urbana, Illinois*
T. C. Chawla, *Argonne, Illinois*
P. M. Chung, *Chicago, Illinois*
S. W. Churchill, *Philadelphia, Pennsylvania*
G. Comini, *Udine, Italy*
G. de Vahl Davis, *Kensington, Australia*
E. R. G. Eckert, *Minneapolis, Minnesota*
A. F. Emery, *Seattle, Washington*
B. A. Finlayson, *Seattle, Washington*
T. Fujii, *Kasuga, Japan*
B. Gebhart, *Philadelphia, Pennsylvania*
J. Gosse, *Paris, France*
P. M. Gresho, *Livermore, California*
E. Hahne, *Stuttgart, FRG*
B. E. Launder, *Manchester, UK*
Y. Mori, *Tokyo, Japan*
S. V. Patankar, *Minneapolis, Minnesota*
R. H. Pletcher, *Ames, Iowa*
G. D. Raithby, *Waterloo, Ontario*
P. J. Roache, *Albuquerque, New Mexico*
W. M. Rohsenow, *Cambridge, Massachusetts*
T.-M. Shih, *College Park, Maryland*
D. B. Spalding, *London, UK*
C. L. Tien, *Berkeley, California*
J. F. Thompson, *Mississippi State, Mississippi*
K. E. Torrance, *Ithaca, New York*
J. H. Whitelaw, *London, UK*
O. C. Zienkiewicz, *Swansea, UK*

AIMS AND SCOPE: *Numerical Heat Transfer* seeks to provide a forum for papers dealing with the methodology and with the results of numerical solutions of problems in heat and mass transfer and in related fluid flows. The methodology papers should describe new or improved formulations of numerical schemes and/or innovative solution techniques. Papers concerned with inputs to the numerical treatment of heat/mass/fluid flow problems, for instance, mathematical modeling of complex physical processes, are also within the scope of the journal. The journal will also publish papers that present results of numerical solutions of heat/mass/fluid flow problems. These results should convey new findings for problems relevant either to basic research or to applications.

EDITORIAL STAFF: Louis M. Fancher, *Editorial Director;* Barbara A. Bodling, *Managing Editor.*

NATIONAL ADVERTISING REPRESENTATIVE: Arthur C. Lipner, Weston Media Associates, 37 Gray's Farm Road, Weston, Connecticut 06883. Phone (203) 226-0478 or (212) 725-1999.

SUBSCRIPTION RATES (Six issues per volume, per year): Institutions—U.S. $199.50, elsewhere $213.50, per year. In order to facilitate the availability of this journal to individuals at a reduced rate, those persons whose affiliated library has subscribed may order a subscription at the special discount rate of $49.50 per year ($63.50 outside the U.S.). To qualify for this discount, the individual's institutional library must be identified on the order card. The special reduced rate is available to individuals not affiliated with an institution, but a statement to this effect must appear on the order card. Individual subscriptions must be accompanied by a personal check or money order.

SUBSCRIPTION SERVICE: Shipments will be made only upon receipt of remittance. All remittances should be sent to Hemisphere's Washington, DC office. All communications related to handling subscriptions, including notifications of change of address, should be sent to Subscriptions Department, Hemisphere Publishing Corp., 79 Madison Ave., New York, NY 10016; phone (212) 725-1999. Change of address notices should provide the old as well as the new address, including zip code number. Changes will become effective within approximately 20 days. Missing copies will be replaced only if valid claims are received within 90 days from date of mailing. Replacements will not be allowed if the subscriber fails to notify the publisher of a change of address or if a copy is misplaced at destination. Request for refund will be honored only prior to delivery of issue number 1 of each volume.

Copyright © 1985 by Hemisphere Publishing Corporation. All rights reserved. Printed in the United States of America. *Numerical Heat Transfer* is owned and published by Hemisphere Publishing Corporation. Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted by Hemisphere Publishing Corporation for libraries and other users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that the base fee of $2.75 per copy plus .00 per page is paid directly to CCC, 27 Congress St., Salem, MA 01970. 0149-5720/85 $2.75 + .00

NUMERICAL HEAT TRANSFER: An International Journal of Computation and Methodology (ISSN 0149-5720) is published bimonthly for $199.50 per year (libraries and institutions) or $49.50 per year (individuals) by Hemisphere Publishing Corporation, 1010 Vermont Ave., N.W., Washington, DC 20005. Second-class postage paid at Washington, DC and additional mailing offices. POSTMASTER: Send address changes to NUMERICAL HEAT TRANSFER: An International Journal of Computation and Methodology, 79 Madison Ave., New York, NY 10016.

HEMISPHERE PUBLISHING CORPORATION
1010 Vermont Ave., N.W., Washington, DC 20005
Phone (202) 783-3958

CONTENTS OF VOLUME 8

NUMBER 1

1 A Literature Survey on Numerical Heat Transfer (1982–1983) **T. M. Shih**

25 Multigrid Techniques for the Solution of the Passive Scalar Advection-Diffusion Equation **R. E. Phillips and F. W. Schmidt**

45 A Numerical Model for Natural Convection in Fluid-Saturated Creeping Porous Media **Paul R. Dawson and David F. McTigue**

65 A Numerical Study of Two-dimensional Natural Convection in Square Open Cavities **Y. L. Chan and C. L. Tien**

81 Heat Transport in a Liquid Column in Weightless Conditions Due to Thermal Marangoni **Helmut F. Bauer**

99 Numerical Recirculating Flow Calculation Using a Body-Fitted Coordinate System **W. Shyy, S. S. Tong, and S. M. Correa**

115 An Algorithm to Reduce Approximation Error from the Complex-Variable Boundary-Element Method Applied to Soil Freezing **T. V. Hromadka II and G. L. Guymon**

131 Announcement and Call for Papers

NUMBER 2

133 A (k-ϵ) Model of Turbulent Flow **G. Comini and S. Del Giudice**

149 Combined Convective and Radiative Recirculating Flows in Enclosures **T. M. Shih and A. L. Ren**

169 Mathematical Modeling of the Transient Operating Characteristics of a Low-Temperature Heat Pipe **Won Soon Chang and Gene T. Colwell**

187 An Analysis of the Computer Modeling of the Flow and Temperature Fields in an Inductively Coupled Plasma **Javad Mostaghimi, Pierre Proulx, and Maher I. Boulos**

203 Low Prandtl Number MHD Convection about a Semi-infinite Horizontal Plate **Graham Wilks and Roland Hunt**

217 Laminar Flow and Heat Transfer in Power-Law Fluids Flowing in Arbitrary Cross-Sectional Ducts **Adeniya Lawal and Arun S. Mujumdar**

245 An Asymptotic Integral Equation Method for the Study of Heat Transfer in Long, Thin Domains **M. A. Kelmanson**

255 Letter to the Editor

257 Announcement

NUMBER 3

259 A Control Volume–Based Finite-Element Method for Solving the Navier-Stokes Equations Using Equal-Order Velocity-Pressure Interpolation **C. Prakash and S. V. Patankar**

281 Comparison of Nine Three-dimensional Numerical Methods for the Solution of the Heat Diffusion Equation **Jules Thibault**

299 Turbulent Heat Transfer in Corotating Annular Disks **Yoon S. Sim and Wen-Jei Yang**

317 Analysis of Transient Natural Convection Flow Near a Vertical Surface at Low Prandtl Number **K. H. Park and V. P. Carey**

335 An Optimized Implicit Scheme for Compressible Reactive Gas Flow **David E. Dietrich and John J. Wormeck**

349 Mixed Convection about a Nonisothermal Cylinder and Sphere in a Porous Medium **W. J. Minkowycz, P. Cheng, and Chong Hyuck Chang**

361 A Study of Turbulent Mass Transport Downstream of an Abrupt Pipe Expansion **R. S. Amano**

373 Convergence Properties of the Heat Balance Integral Method **Graham E. Bell and Suhama K. Abbas**

NUMBER 4

383 Three-dimensional Numerical Analysis of Natural Convection in a Spherical Annulus **Hiroyuki Ozoe, Keiichi Fujii, Tsutomu Shibata, Hisashi Kuriyama, and Stuart W. Churchill**

407 Natural Convection in a Fully Partitioned, Inclined Enclosure **S. Acharya and C. H. Tsang**

429 Mixed Laminar Convection in a Participating Irradiated Fluid—1. **G. Camera-Roda, M. Bertelà, and F. Santarelli**

449 The Two-dimensional Laminar Vertical Jet with Positive or Adverse Buoyancy **Graham Wilks, Roland Hunt, and David S. Riley**

469 Heat Transfer through a Rectangular Solid with a Gas-Filled Cylindrical Hole **P. Ranganathan and R. Viskanta**

485 A Boundary Integral Equation Method for the Study of Some Laminar Forced Convection Problems **K. R. Rajagopal and A. M. Sadegh**

TECHNICAL NOTE

497 On the Numerical Solution of Hyperbolic Heat Conduction **D. E. Glass, M. N. Özişik, D. S. McRae, and Brian Vick**

NUMBER 5

505 A Critical Look at the Progress in Numerical Heat Transfer and Some Suggestions for Improvement **Ashok K. Singhal**

519 Additional Performance Aspects of Marching Methods for Elliptic Equations **Patrick J. Roache**

537 A Coupled Strongly Implicit Procedure for Velocity and Pressure Computation in Fluid Flow Problems **M. Zedan and G. E. Schneider**

559 A New Implicit Solution Procedure for Multidimensional Finite-Difference Modeling of the Stefan Problem **M. J. Raw and G. E. Schneider**

573 A Multilevel-Multigrid Technique for Recirculating Flows **R. E. Phillips and F. W. Schmidt**

595 Solution of the Convection-Diffusion Equation by a Finite-Element Method Using Quadrilateral Elements **S. Ramadhyani and S. V. Patankar**

613 Three-dimensional Convection in Horizontal Cylinders: Numerical Solutions and Comparison with Experimental and Analytical Results **C. Smutek, P. Bontoux, B. Roux, G. H. Schiroky, A. C. Hurford, F. Rosenberger, and G. de Vahl Davis**

633 Announcement

NUMBER 6

635 Comparison of Pressure-Velocity Coupling Solution Algorithms **B. R. Latimer and A. Pollard**

653 An Efficient Algorithm for Finite-Difference Analyses of Heat Transfer with Melting and Solidification **J. S. Hsiao**

667 Forced Convection Evaporation from a Cavity Containing a Liquid Whose Surface Is Curved by Capillarity: Computations in Interlocking Rectangular and Cylindrical Domains **A. T. Prata and E. M. Sparrow**

689 Numerical Evaluation of Heat and Mass Transfer to a Moving Liquid Drop Experiencing Condensation **T. Sundararajan and P. S. Ayyaswamy**

707 Numerical Simulation of Laminar Mixed Convection in the Entrance Region of Horizontal Rectangular Ducts **F. P. Incropera and J. A. Schutt**

731 Modeling of the Transport Phenomena in the Anode Region of High Current Arcs **H. Wilhelmi, W. Wimmer, and E. Pfender**

751 Dynamics of Transient States of the Counterflow Heat Regenerator **Z. Wozniak**

FOLLOWING PAGE 760:

Title Page to Volume 8
Contents of Volume 8
Author Index to Volume 8
Subject Index to Volume 8